INTRODUCTION:

A Quality Assurance (QA) program, which includes quality control tests, helps to ensure that high quality diagnostic images are consistently produced while minimizing radiation exposure. The QA program covers the entire x-ray system (i.e.) Fixed X-ray units, Mobile units, C-Arm, CT scan and CathLab. This program will enable the facility to recognize when parameters are out of limits, which could result in poor quality images and can increase the radiation exposure to patients. Simply performing the quality control tests is not sufficient. When quality control test results exceed established operating parameters, appropriate corrective action must be taken immediately and documented.

Implementation of the QA program is accomplished through the work of several people. The QA Manual is the unifying element bringing together information about what the QC tests are, how the tests are performed, who performs them, and what records must be kept.

QUALITY CONTROL MEASURE:

Includes;

- A list of the QC Tests that will be performed and the frequency of each test.
- A list of x-ray equipment to be tested.
- Acceptable limits for each test performed.
- A description of each QC test procedure.
- Sample forms that are used for each QC test performed.

POLICIES AND PROCEDURES:

- The written policies and procedures are formed and implemented for the following: -
- Policy for holding patients and for presence of individuals in room during radiation exposure.
- Policy for pregnant patients and employees.

DEFINITIONS

QUALITY ASSURANCE:

It is a plan that involves continuous monitoring to ensure regular testing to detect equipment malfunction, regularly scheduled equipment maintenance, and an ongoing assessment of variables that could affect image quality and diagnosis. The quality assurance program includes many facets, including quality control, as well as preventive maintenance and calibration of equipment.

QUALITY CONTROL:

It is an integral part of quality assurance. It is a series of distinct technical procedures and tests that ensure the production of a satisfactory product, e.g., high-quality diagnostic images. These tests will enable the facility to recognize when parameters are out of limits. Out of limits parameters result in poor quality images and can increase the radiation exposure to patients. Simply performing the quality control tests will not result in any useful information if the data is

not evaluated. Whenever quality control test results exceed established operating parameters, corrective action is required immediately.

LIST OF EQUIPMENTS TO BE TESTED:

- Fixed X-ray Unit (500 MA unit)
- Mobile X-ray unit
- C-Arm unit
- CT Machine
- Angiography Unit

QUALITY ASSURANCE TESTS FOR DIAGNOSTIC:

X-RAY EQUIPMENTS:

Quality assurance programme for diagnostic x-ray units is aimed to ensure that the image produced is consistently of high quality giving maximum diagnostic information with minimum radiation exposure to the patient at minimal cost. By this repeat X-rays can be avoided thereby saving valuable film, reducing dose of radiation to patient and operator and also prolonging the life of the X-ray tube. Proper alignment and correct field size are necessary to give essential information for diagnosis. Temperature of processing solutions, time of development, fixing and washing should be standardized taking into account manufacturers recommendations to get optimum results.

QUALITY CONTROL TEST FREQUENCY:

EACH DAY OF OPERATION:

Equipment functioning:

- Indicators and mechanical and safety checks

Semi-annually:

Collimators

- Light field/x-ray alignment
- X-ray field / image receptor alignment

Fluoroscopic image receptor/x-ray field alignment

- Radiographic timers
- KVP
- MA linearity
- Exposure switches
- Aprons, gloves and drapes

Annually:

- HVL
- Fluoroscopic timers
- Fluoroscopic tabletop exposure rates
- Film / screen contact
- SID indicators

On Installation of New Equipment/Tube or Output Change:

- Radiation protection surveys
- Acceptance testing
- Average patient exposures for common x-ray examinations

DAILY X-RAY EQUIPMENT TESTS:

Model of the equipment: **Month:**

TESTS	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
I. Mechanical 1. Locking facility for immobilizing the x-ray tube satisfactory.															
2. Movement of collimator jaws satisfactory.															
3. Tube orientation indication satisfactory.															
II. Display / Indicators: 1. Beam "ON" display satisfactory.															
2. Tube current (mA) display satisfactory.															

3. Tube potential display (kVp) satisfactory.															
4. Exposure time selection satisfactory.															
5. Bucky indicator working.															
6. Field light working.															
III. Exposure switch working															
IV. Audible signal during or at the end of exposure															
RADIOGRAPHER'S SIGN.															

Make & Model of the equipment :

Date of Measurement :

Instruments used :

Survey instrument used :

Done by :

RADIATION CHARACTERISTICS:

1. Congruence of Radiation and Optical fields & Central Beam Alignment Focus to Film Distance:

Result:

a. Shift of the edges of the radiation field

X = cm % of TFD X' = cm % of TFD

Y = cm % of TFD Y' = cm % of TFD

Tolerance: 2% of TFD

b. Difference in the dimensions of the radiation and optical fields

X+X' = cm % of TFD

Y+Y' = cm % of TFD

Tolerance: 3% of TFD

c. Difference between sums of lengths and widths of optical and radiation fields

X+X'+Y+Y' = cm % of TFD

Tolerance: 4% of TFD

d. Observe the images of the two steel balls on the radiograph and evaluate tilt in the central beam.

Result: The tilt in the central beam is = Tolerance: Tilt < 1.5°

2. Accelerating Voltage:

Result:

Set KVP	Measured KVP

Tolerance: ± 5kV

3. Linearity of mA loading Station:

Operating Potential 70<kV<85 kV: sec:

mA range	mA	X, Instrument Reading (µGy)					Avg	µGy / mAs "X"
		1	2	3	4	5		
50<i<100								
100<i<200								
100<i<300								
100<i<400								

$$\text{Coefficient of Linearity (COL)} = \frac{X_{max} - X_{min}}{X_{max} + X_{min}}$$

Result: Coefficient of Linearity for mA loading stations are

Tolerance: COL < 0.1

4. Linearity of Timer:

kVp: mA:

Time (sec)	s	X, Instrument Reading(µGy)					Avg	µGy/mAs "X"
		1	2	3	4	5		

Result: Coefficient of Linearity of timer of the unit is

Tolerance: Coefficient of Linearity <0.1

5. Output consistency

Operating Potential	mAs	X, Instrument Reading (µGy)					Avg	µGy / mAs "X"
		1	2	3	4	5		

Coefficient of Variation:

Tolerance: COV < 0.05

QUALITY ASSURANCE TESTS FOR COMPUTED:

TOMOGRAPHY (CT) SCANNER:

Quality control test frequency

Daily:

- Equipment functioning
- CT number Accuracy of water
- Field uniformity

- Artifacts

Semi-annually

Mechanical Tests:

- Gantry Tilt
- Table Position / incrementation

Collimation Test

- Radiation Profile Width

Tests on X-ray Generator:

- Measurement of operating Potential
- Measurement of mA linearity
- Measurement of timer linearity
- Output consistency

Radiation Dose Tests:

- Measurement of Computed Tomography Dose Index (CTDI)

DAILY CT EQUIPMENT TESTS:

Model of the equipment: **Month:**

DATE	EQUIPMENT FUNCTION	CT NUMBER FOR WATER	FIELD UNIFORMITY & ARTIFACTS	RADIOGRAPHERS SIGNATURE

MECHANICAL TESTS:

1. Gantry Tilt

Exposure Parameters: kVp: mAs:

Result

Actual gantry tilt :

Measured gantry tilt :

Tolerance : ± 3°

2. Table Position / incrementation

Initial table position (arbitrary):

Load on couch :

Exposure parameters: kVp: mAs: Slice thickness:

Applied table incrementation:

Table position from Reference position	1cm	2cm	3cm	4cm	5cm
Expected					
Measured					

Tolerance: ± 2.0 mm

COLLIMATION TESTS:

1. Radiation Profile Width

Exposure Parameters: kVp: mAs:

Result:

Applied Slice thickness (mm)	Measured density profile Width(FWHM)

Tolerance: ± 1.0mm (without post patient collimation)

TESTS ON X-RAY GENERATOR:

1. Measurement of operating potential

Set kV	mA station I	mA station II	mA station III	mA station IV

Tolerance: ± 2 kVp

2. Measurement of mA linearity:

Operating parameters: kVp: Slice thickness: Time:

mA settings	mAs	Output µGy	µGy / mAs (X)

$$\text{Coefficient of linearity (COL)} = \frac{X_{max} - X_{min}}{X_{max} + X_{min}}$$

Tolerance in COL: ± 0.05

3. Measurement of timer linearity:

Operating parameters: kVp: Slice thickness: mA:

Timer Settings S	mAs	Output (µGy)	µGy / mAs

kVp	Output mGy					Mean (X)	COV

Coefficient of Linearity:

Tolerance: ± 0.05

4. Output Consistency:

Operating parameters: mAs: Slice thickness:

Coefficient of Variation (COV) = $X^{-1}(\Sigma[X_i - X]^2 / n-1)^{½}$

Tolerance in COV: ± 0.05

RADIATION DOSE TEST:

1. Measurement of Computed Tomography Dose Index (CTDI)

Operating Parameters: kVp: 80 /100/ 120 mAs: 100 Slice Thickness:

Result:

Head	Body	
Axial Dose	mGy/mAs	mGy/mAs
Peripheral Dose (T)	mGy/mAs	mGy/mAs
(B)	mGy/mAs	mGy/mAs
®	mGy/mAs	mGy/mAs
(L)	mGy/mAs	mGy/mAs
Peripheral dose (Mean)	mGy/mAs	mGy/mAs
$CTDI_c$	mGy/mAs	mGy/mAs
$CTDI_{p\ (mean)}$	mGy/mAs	mGy/mAs

Weighted CTDI ($CTDI_w$) = 1/3 $CTDI_c$ + 2/3 $CTDI_p$

$CTDI_w$ = ---------mGy/mAs

Tolerance: ± 20% of the quoted value (Expected)

± 40% of the quoted value (maximum)

TEST METHODS

1. LIGHT FIELD/X-RAY FIELD ALIGNMENT TEST:

PURPOSE:

To assure that the x-ray field and light field are congruent.

LIMITS:

- 2% of Source-Image-Distance (SID) misalignment along either the horizontal or vertical edges of the light field vs. the x-ray field.
- Test Frequency:

ANNUALLY:

SID = 40"

TECHNIQUE FACTORS:

60 kVp, 5 mAs

TEST TOOLS:

Loaded 8"x10" or similar size cassette, Collimator Test tool

PROCEDURES:

1. Place loaded cassette on x-ray table.
2. Center light field to the center of the cassette at a 40" (100cm) SID.
3. Place the collimator Test tool on the cassette.
4. Collimate beam to approximately a 5"x7" beam.
5. Expose and develop the film.

6. Examine each of the four sides of the exposed film.

7. Misalignment in either dimension (horizontal misalignment is the sum of the deviation of the right and left edges, vertical misalignment is the sum of the top and bottom edges) cannot exceed 0.8 inches.

2. X-RAY FIELD/IMAGE RECEPTOR ALIGNMENT:

PURPOSE:

To assure that the x-ray field is centered to the cassette and the bucky tray.

LIMITS:

- The misalignment of the center of the x-ray field as compared to the center of the film shall not exceed 2% of the SID. 2% of 40" = 0.8 inches
- Test Frequency

ANNUALLY:

SID = 40"

TECHNIQUE FACTORS:

70 kVp @ 10mAs

TEST TOOLS:

Loaded cassette, Collimator and Beam alignment Test tool

PROCEDURE:

1. Place a 8x10 cassette in the bucky tray, center the film in the tray, and lock into place.
2. Make sure that the x-ray tube is centered to the table using the transverse locking mechanism on the x-ray tube.
3. Center the bucky tray to the collimator centering light.
4. Set x-ray tube to 40" SID.
5. Position the collimator test tool on the cassette
6. Manually collimate light field to leave to 1 inch border on the film. This will leave an unexposed border on the film after processing.

7. Expose and process the film.
8. To find the center of the film, place a ruler at opposite corners of the film and draw a line. The point where the two lines cross is the center of the film.
9. To find the center of the exposed portion of the film, place the ruler at opposite corners of the exposed portion of the film and draw a line. The point where the two lines cross is the center of the exposed field.
10. Measure the distance between the center point of the film and the center point of the exposed field.
11. Record this information.

RESULT:

Tolerance = 2% of SID

3. LEAD APRONS, GLOVES AND DRAPES:

- Protective garments and drapes shall not have tears, which impair their radiation protection function. Lead aprons, gloves, thyroid shielding integrity check is done annually.
- If integrity is failed, appropriate person(s) notified.

FLUOROSCOPIC QUALITY ASSURANCE TESTS

QUALITY CONTROL TEST FREQUENCY:

ANNUALLY:

- Beam Alignment
- Collimation (Fluoroscopic / Spot film)
- Maximum Exposure Rate (Table Top Exposure)
- Lead Aprons Integrity check

1. CENTRAL BEAM ALIGNMENT:

Observe the images of the two steel balls on the radiograph and evaluate tilt in the central beam.

Result: The tilt in the central beam is

Tolerance: Tilt < 1.5°

2. FLUOROSCOPIC COLLIMATION:

(From Image Intensifier)

SID =

a. Shift of the edges of the radiation field

X = cm % of SID X' = cm % of SID

Y = cm % of SID Y' = cm % of SID

Tolerance: 3% of SID

3. SPOT FILM COLLIMATION:

(From film)

SID=

Film to be enclosed

4. MAXIMUM EXPOSURE RATE (TABLE TOP EXPOSURE):

Measured with divider (Lead) in place =

Tolerance: 5cGy / min

QA TESTS FOR FLUOROSCOPIC UNITS – METHOD:

1. Beam alignment – Set the collimator and beam alignment tool. Keep the II at 30 cms from the table. Observe the steel balls.
2. Symmetry of field to be checked on the screen
3. Spot film check – Ordinary film. Spot film exposure factors. 60kVp, 1-2 mA 15 seconds
4. Maximum Exposure rate
    a. Lead sheet (Divider) or apron at II. Measure at Table Top for under table tube.
    b. For C-Arm Exposure meter at 30 cm from the front surface of the image intensifier

POLICIES AND PROCEDURES:

The following policies and procedures have been adopted in our hospital

POLICY FOR HOLDING PATIENTS AND FOR PRESENCE OF INDIVIDUALS IN THE ROOM DURING RADIATION EXPOSURE:

POLICY FOR HOLDING PATIENTS:

1. Only a qualified (as per AERB norms) will be permitted to operate x-ray equipment and position a patient for a radiographic procedure.
2. No person will be employed, routinely assigned, or required to hold a patient during radiographic and fluoroscopic procedures.
3. If a patient must be held during the x-ray exposure, non-radiation workers such as aides, orderlies, nurses, or members of the patient's family may be asked to perform this duty.
4 .No person other than the patient will hold the film during the exposure.
5. No person will order, instruct or otherwise allow a person under the age of 19 to hold a patient during any radiographic, fluoroscopic or therapy simulation procedure.
6. The person holding the patient will be protected with a lead apron of at least 0.25 mm lead equivalent.
7. The person holding the patient will be protected with lead gloves of at least 0.25 mm lead equivalent when hands are in the radiation beam.

POLICY FOR PRESENCE OF INDIVIDUALS IN THE ROOM DURING RADIATION EXPOSURE:

1. Only individuals required for the medical procedure, for training, or for equipment maintenance will be permitted in the radiographic, fluoroscopic or computed tomography rooms during an exposure.
2. Individuals who are present in the radiographic, fluoroscopic, or computed tomography room during any exposure will wear protective aprons of a least 0.25 mm lead equivalent during every exposure.
3. Individuals whose hands may be in the primary beam will be required to wear protective gloves of at least 0.25 mm lead equivalent.
4. Observation of the patient will be made from behind the protective barrier.

POLICY FOR PREGNANT PATIENTS AND EMPLOYEES:

POLICY FOR PREGNANT PATIENTS:

1. Before an x-ray examination, the x-ray operator(s) will ask female patients of child bearing age about the possibility of pregnancy. If the patient is unsure, the x-ray procedure will be delayed until the pregnancy status is confirmed.
2. For a confirmed pregnancy, the patient's referring physician will be called to determine if the x-ray exam can be postponed until after the patient is no longer pregnant. If the consultation determines that the x-ray exam is immediately necessary for the mother's health, then every precaution will be taken to protect the fetus.
3. Signs are posted in the waiting room and the x-ray room reminding the patient to inform the doctor (Radiographers, if applicable) if they are or suspect that they are pregnant.

POLICY FOR PREGNANT EMPLOYEES:

1. The staff and the pregnant employee will work together to try to limit the radiation exposure to the unborn child. Methods that we use are as follows:
    a) Reduce the time spent in the radiation area, by working out a schedule to modify the duties during the time of the pregnancy.
    b) Stand in a shielded area during all radiographs.
    c) Keep an extra distance from the radiation source whenever possible.
2. Employees working in radiation prone area are shifted to non-radiation areas during the pregnancy tenure.